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Impact of Obesity on Biochemical Markers among Patients with Chronic Diseases

Dr. Maha A. Al Turki[1], Dr. Mohamed Abdulfattah[2], Alhanouf N. Al Dossri[3], Hanin A. Al Dusaymani[4], Nada M. Al Shutwi[5], Dr. Tarig Karar[6].

[1]Clinical Nutrition Department, College of Applied Medical Sciences, King Saud bin Abdulaziz University for Health Sciences, Riyadh, Saudi Arabia
King Abdulla International Medical Research Centre, Riyadh, Saudi Arabia

[2]Clinical Laboratory Department, College of Applied Medical Sciences, King Saud bin Abdulaziz University for Health Sciences, Riyadh, Saudi Arabia
King Abdulla International Medical Research Centre, Riyadh, Saudi Arabia

[3]Clinical Nutrition Department, College of Applied Medical Sciences, King Saud bin Abdulaziz University for Health Sciences, Riyadh, Saudi Arabia

[4]Clinical Nutrition Department, College of Applied Medical Sciences, King Saud bin Abdulaziz University for Health Sciences, Riyadh, Saudi Arabia

[5]Clinical Nutrition Department, College of Applied Medical Sciences, King Saud bin Abdulaziz University for Health Sciences, Riyadh, Saudi Arabia

[6]Clinical Laboratory Department, College of Applied Medical Sciences, King Saud bin Abdulaziz University for Health Sciences, Riyadh, Saudi Arabia
King Abdulla International Medical Research Centre, Riyadh, Saudi Arabia

ABSTRACT

Background

Extensive epidemiological research has reported that excess body weight for height is associated with several alterations at the hormonal, inflammatory, metabolic, and endothelial levels. The current study aimed to examine the association between body mass index (BMI) classifications and the chemical biomarker status of patients diagnosed with chronic diseases. Methodology: The study was designed as a cross-sectional study of 431 patients attending King Abdulaziz Medical City for the period between 2008 and 2019. Information regarding age, gender, height, weight, BMI, and biochemical data (hemoglobin A1c, triglyceride, cholesterol, and albumin) was collected. Results: Overweight and obesity were detected among 43% of the total sample. A greater percentage of patients diagnosed with diabetes mellitus, hypertension, and hypothyroidism were overweight and obese ($p = 0.027$). Triglyceride levels were significantly higher among obese individuals compared with non-obese ($p = 0.039$). No significant difference was found in the level of hemoglobin A1c, cholesterol, and albumin between the two groups. Serum triglyceride level was positively associated with BMI categories among our sample ($\beta = 0.734$; standard error [SE] = 0.290, $p = 0.012$). Conclusion: In patients diagnosed with chronic disease, elevated triglyceride levels are independently associated with BMI classifications. Increase weight did not seem to be related to the levels of HbA1c, cholesterol, or albumin. The results emphasize the importance of assessing hypertriglyceridemia among patients with obesity and diagnosed with chronic disease to improve health status and avoid further comorbidities.

Keywords: Obesity, Hemoglobin A1c, Cholesterol Level, Albumin Level, Triglyceride Level.

BACKGROUND

The prevalence of obesity and obesity-related comorbidities is increasing dramatically worldwide[1]. There is convincing evidence of a positive association between obesity and several comorbid conditions[2]. This is probably because intra-abdominal fat is sensitive to lipolysis and causes excessive flow of free fatty acids into the portal vein, which inhibits insulin-stimulated glucose uptake[3]. This leads to increased glucose status and elevates insulin synthesis and predisposes individuals to hypertension, hyperinsulinemia, and hyperlipidemia.

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A rise in the adipose tissue concentration in the body induces dysregulation in many secretory factors. Referring to these factors, adipocytokines/adipokines are bioactive substances produced by adipose tissue, which may cause many metabolic disorders due to the alteration in glucose and lipid homeostasis, causing insulin resistance and diabetes[4]. Currently, there is great interest not only in understanding the etiological role of obesity in the development of chronic disease but also exploring in depth the abnormalities that contribute to different biomarkers seen in patients with obesity.

Glycated hemoglobin (hemoglobin A1c [HbA1c]) is a measure of long-term glucose regulation, and it is considered a diagnostic tool of type 2 diabetes mellitus. Literature has emerged that offers contradictory findings about the association between HbA1c and body mass index (BMI). Several studies have reported positive associations, but others did not find any relationship[5,6,7].

Despite the influence of obesity on the lipoprotein cholesterol and triglycerides was established, some data have suggested that this paradigm may be oversimplified. In fact, some studies have found that extremely (BMI 61 kg/m^2) and severely (BMI 46 and<60 kg/m^2) obese individuals had better lipid profiles than moderately obese ones[8]. Moreover, in the NHANES III study, the group with a BMI of ≥ 35 kg/m^2 was reported to have a lower prevalence of hyperlipidemia compared with the other three groups with lower BMI status[9].Abdominal obesity and BMI have also received attention as a potential early risk factor for increased albuminuria, independent of blood pressure, glucose level, and renal status[10, 11,12]. In a longitudinal study conducted in the general population, weight changes were associated with changes in albuminuria [13].

For understanding the link between obesity and chronic diseases, it is critical for healthcare providers to consider different biomarkers for patient diagnosis and management. Physicians need to be aware of obesity comorbidities and their implications for clinical biomarkers and health management of obese individuals. While triglyceride, HbA1c, cholesterol, and albumin are commonly used indicators of chronic disease, there are contradictory views on whether these biomarkers are sufficiently reliable for patients with obesity. There have been few studies on the influence of obesity on some of these biomarkers among Saudi individuals diagnosed with chronic disease. This study aims to contribute to this growing area of research by evaluating the association between BMI and several biochemical markers among patients diagnosed with diabetes, hypertension, and hypothyroidism. It also gives insight into the prevalence of obesity/overweight among this group.

MATERIALS AND METHODS

A retrospective cross-sectional study was conducted at one of the main medical cities in Riyadh, Saudi Arabia, for patients admitted during the period between 2008 and 2019.Patients aged 18 years and over with a diagnosis of one or more of three chronic diseases—diabetes, hypertension, or hypothyroidism—were included in our study and then clustered into obese and non-obese groups. Patients diagnosed with other chronic diseases, such as renal impairment and cardiac disease, were excluded. The total sample size was calculated using a 95%confidence limit and a 0.05 margin of error, which was equal to 450 patients. All patients who were admitted to the hospital during the mentioned period and who satisfied the inclusion criteria were selected in the study group.

DATA COLLECTION

A list of potential subjects was obtained by accessing the patients' medical records. An initial assessment for eligible patients who met the inclusion criteria was included in the study. The patients were clustered into three groups according to their disease (diabetes, hypertension, or hypothyroidism), then divided into subgroups (obese and non-obese). All required data were recorded immediately after initial diagnosis of the disease, including biochemical data (HbA1c, cholesterol, triglyceride, and albumin), demographic data (gender, age), and anthropometric measurements (height, weight, BMI).

DATA MANAGEMENT AND ANALYSIS PLAN

The collected data were entered Microsoft Excel and then exported to SPSS (Version 20.0 for Windows). An independent *t*-test was used to compare the biochemical markers between the study groups. Pearson correlation was applied to test the correlation between the BMI and other biomarkers. An analysis of variance (ANOVA) test was also used to compare chemical biomarkers among the three chronic diseases.

The study population was further classified according to BMI into six classes, which were divided as follows: underweight (< 18.5 kg/m^2), normal weight (18.5–24.9 kg/m^2), overweight (25.0–29.9 kg/m^2), obese class I(30.0–34.9 kg/m^2), obese class II(35.0–39.9 kg/m^2), and obese class III (≥40.0 kg/m^2). Then,

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patients were divided into two main categories as follows: non-obese (underweight, normal weight, overweight) and obese (obese class I, obese class II, obese class III) subjects.

A *p*-value < 0.05 was considered statistically significant in our analysis. Frequencies and percentages were used to represent categorical variables, whereas means and standard deviations (SDs) were used for continuous variables. Tables and figures are used to represent the results.

RESULTS

CHARACTERISTICS OF STUDY SAMPLE

From an initial sample of 450 patients' records, 431 patients were included in the study. Patients were distributed into three main groups as follows: group 1 included 151 (35%) patients diagnosed with diabetes mellitus, group 2 included 160 (37%) patients diagnosed with hypertension, and group 3 included 120 (28%) patients diagnosed with hypothyroidism (Table 1).

The mean age ±SD of the sample was 54.78 ±21.10 years, and the mean ±SD BMI was 29.68 ±7.33 kg/m^2. The mean BMI of patients under the three chronic disease groups was in the overweight and obesity categories. Twenty-nine percent of the study participants were overweight (BMI = 25.0–29.9 kg/m^2), whereas 24% were moderately obese (BMI = 35.0–39.9 kg/m^2). A higher BMI level was detected among the hypothyroidism patients (BMI=59 kg/m^2), while in the diabetes and hypertension groups, the BMI levels were found to be 53.9 kg/m^2 and 55.7 kg/m^2, respectively (p= 0.027). Figure (1) show the status if biochemical markers among each group.

The total sample was categorized into obese (BMI ≥30kg/m^2) and non-obese (BMI <30kg/m^2) groups for further analysis (Table 2). The mean age ±SD of the obese group was 56.88±18.72 years. The non-obese group (mean age ±SD:53.18±22.64 years) was younger than the other group was (p<0.001). Significantly greater percentages of the females (69%) in the total sample were categorized in the obese group (p=0.047).

Table 1. General Characteristics of the Study Sample According to Chronic Disease Groups [*]

Variables	All subjects (n = 431)	Diabetic patients (n = 151)	Hypertension patients (n = 160)	Hypothyroidism patients (n = 120)
Age (years)	54.78±21.10	33.96±15.41	64.52±11.73	68.32±15.77
Height (m)	160.24±9.11	160.27±9.13	162.82±8.63	156.75±8.61
Weight (kg)	75.90±17.81	72.91±17.54	79.37±16.74	75.03±18.85
BMI (kg/m^2)	29.68±7.33	28.45±6.82	30.03±6.79	30.76±8.42
Gender (female)[†]	228 (52%)	96 (63.5%)	50 (31%)	82 (68%)

BMI= Body Mass Index.

[*]Data are presented as mean ± SD

[†]Data are presented as n (%)

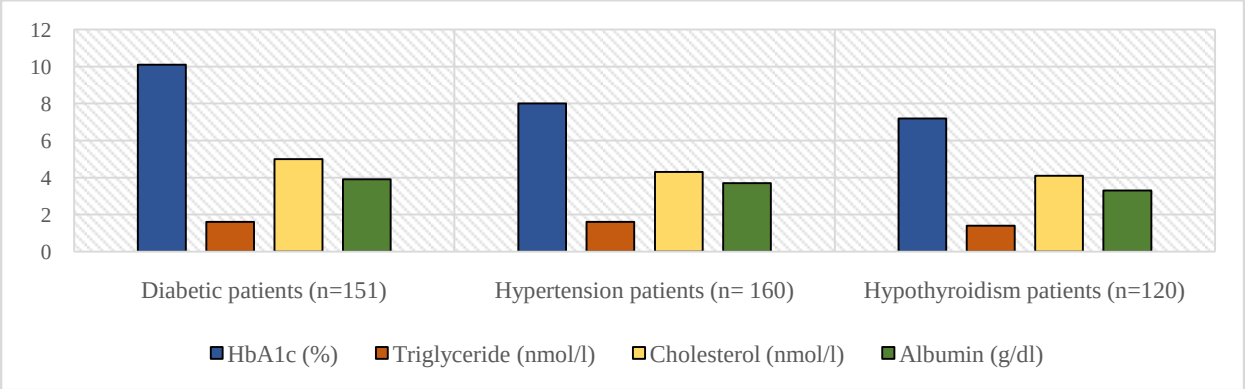

Figure 1. Biochemical markers status according to chronic disease group

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Table 2. General Characteristics of Obese and Non-Obese Patients[*].

Variables	All subjects (n = 431)	Obese group (n = 186)	Non-obese group (n = 245)	p-value
Age (years)	54.78±21.10	56.88±18.72	53.18±22.64	<0.001
Height (m)	160.24±9.11	157.71±9.20	162.15±8.57	0.313
Weight (kg)	75.90±17.81	89.96±14.20	65.23±11.88	0.019
BMI (kg/m^2)	29.68±7.33	36.23±5.76	24.71±3.50	<0.001
Gender (female)[†]	228 (52%)	129 (69%)	99 (40%)	0.047[‡]

BMI= Body Mass Index.

[*]Data are presented as mean ± SD

[†]Data are presented as n (%)

[‡]Chi-square test

ASSOCIATION BETWEEN BMI AND BIOCHEMICAL MARKER STATUS

Table 3 provides descriptive data for the biomarker levels in different study groups according to patients' BMI category status. There was a significant difference in triglyceride levels between obese and non-obese patients (p = 0.039). However, no significant difference was found in the status of HbA1c, cholesterol, or albumin when comparing obese with non-obese individuals (Table 4).

A significant correlation was also observed between the BMI and serum triglyceride level (r= 0.101, p=0.037). However, HbA1c, cholesterol, and albumin levels did not correlate significantly with BMI in this population.

REGRESSION ANALYSIS WITH BMIAS DEPENDENT VARIABLE

Regression analysis for BMI as a dependent variable indicated that the serum triglyceride level (β=0.734; standard error [SE] =0.290) was positively associated with BMI categories among our sample (p=0.012). The model explained 1% of the BMI variability (Table 5). In contrast,HbA1c, cholesterol, and albumin levels did not contribute significantly to the BMI variation in our sample of patients diagnosed with chronic diseases.

Table 3. Biomarker Levels in Different Study Groups According to BMI Category Status

BMI category status	HbA1c (%)		Triglyceride (mmol/L)		Cholesterol (mmol/L)		Albumin (g/L)	
	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD	Range
Underweight (n = 13)	8.69 ± 4.03	3.30–15.80	1.116 ± 0.45	0.34–1.90	3.79 ± 1.30	1.77–5.80	37.15 ± 9.33	22–53
Normal (n = 107)	8.75 ± 2.72	4.70–16.00	1.33 ± 0.78	0.30–4.80	4.62 ± 1.55	2.07–10.68	37.40 ± 7.59	16–54
Overweight (n = 125)	8.39 ± 2.57	4.50–16.0	1.60 ± 1.65	0.44–17.0	4.41 ± 1.56	1.33–9.46	36.96 ± 6.82	17–47
Obese class I (n = 103)	8.61 ± 2.71	4.80–15.30	1.70 ± 1.19	0.37–8.61	4.72 ± 1.14	2.14–9.00	38.38 ± 6.22	19–52
Obese class II (n = 46)	8.43 ± 2.59	4.60–14.70	1.80 ± 0.95	0.44–4.27	4.64 ± 1.41	1.59–8.58	36.91 ± 5.94	21–52
Obese class III (n = 37)	8.30 ± 2.21	4.50–14.90	1.72 ± 2.22	0.47–14.24	4.24 ± 1.56	1.09–10.47	35.11 ± 5.05	29–48

SD = Standard deviation, HbA1c = hemoglobin A1c. BMI classification: < 18.5 = underweight, 18.5–24.9 = normal weight, 25.0–29.9 = overweight, 30.0–34.9 = obese class I, 35.0–39.9 = obese class II, ≥40.0 = obese class III

DISCUSSION

The present study explores the prevalence of obesity among adult patients with a diagnosis of different chronic diseases and attending one of the main medical cities in Riyadh. It also aims to detect any associations between several biochemical markers and different BMI classifications among those patients. In our sample, the mean ± SD BMI was found to be in the obese range (29.68 ±7.33 kg/m^2). Fifty-three percent of the study patients were overweight or moderately obese. Extensive research has shown that obesity is a chronic condition that contributes to a range of chronic diseases in the population[2, 14, 15, 16]. Kearns *et al*. estimated the effect of a 1-unit reduction in BMI on the overall burden of chronic disease in a cross-sectional

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analysis of the Republic of Ireland National Survey of Lifestyle, Attitudes and Nutrition, and reported a 4% reduction in the prevalence of chronic disease among both males and females[17].

In our research, we analyzed the serum triglyceride levels of non-obese patients and patients with varying degrees of obesity. Serum triglyceride was found to be significantly greater among patients with more body fat when compared with leaner patients. Moreover, in an advanced multivariate regression analysis with BMI as an independent variable and all biomarkers as dependent variables, the serum triglyceride level was found to be the only biomarker that positively predicted BMI among patients. This finding corresponds well with the observations reported in previous studies[18, 19]. Some investigators have explored the pathophysiology of hypertriglyceridemia in obesity and suggested that increasing liver fat content in obese individuals can cause dual metabolic defects that are a combination of increased triglyceride secretion and impaired clearance of VLDL1-triglyceride particles[20]. Another possible explanation is that hypertriglyceridemia and obesity are linked to insulin resistance. An increase in insulin resistance among individuals with obesity has been reported to have a more adverse effect on blood triglyceride levels[21].

Although the present study did not detect any significant difference between obesity and the levels of HbA1c, cholesterol, and albumin, the means of cholesterol and albumin levels were higher in obese individuals. There has been much debate on whether the level of cholesterol increases in some individuals due to genetic factors or due to anthropometric and/or lifestyle factors. Our results reflect those of Brown *et al.*, who also found that the mean levels of cholesterol did not rise consistently with increasing BMI above 25 kg/m^2[22]. A consistent finding was also observed in our descriptive analysis, where a greater increase in the cholesterol level was found between the underweight (3.79±1.30) and normal (4.62 ± 1.55) categories than among the other categories. The absence of a significant association with obesity among the BMI subgroups may be due to the influence of other factors influencing HbA1c, cholesterol, and albumin levels and that were not accounted for in the present study, including dietary intake.

More recently, literature has emerged that offers contradictory findings about the influence of obesity on both albumin and HbA1c status. Several studies have reported a negative association between obesity and albumin levels among adults and children[23]. In contrast, other research has investigated the pattern of changes in serum albumin levels after mini-gastric bypass and found no significant change during 1year of follow-up[24]. Among our sample, we failed to demonstrate any association between BMI categories and HbA1c status. This outcome is contrary to that reported by previous studies, which have shown a positive correlation between BMI and HbA1c[25,26]. The reasons for these inconsistent findings on the association between obesity and albumin and HbA1c statuses remain unknown. It appears that the inconsistency in the findings could be caused by variations in age and race among the study samples.

Rapidly increasing obesity prevalence rates require weight management to be a priority for the prevention and treatment of chronic diseases. A population approach targeting the whole population may be more effective than targeting only the high-risk population. Nevertheless, the current study reinforces the importance of testing for hypertriglyceridemia among obese patients diagnosed with chronic disease to reduce the risk of developing adverse cardiovascular events.

In the current study, number of limitations need to be considered. Across-sectional design was adopted for this study, making it difficult to determine whether the exposure or outcome came first. This study also lacks cofounding factors for adjustment, such as treatment, medications, and genetic factors, which may have indirectly affected the results. Furthermore, BMI was used in the present analysis as a sole indicator to categorize the sample into obese and non-obese groups. It is important to bear in mind that BM Iis merely a ratio of weight to height and does not differentiate between fat and lean body mass. Waist circumference, hip circumference, and, the waist–hip ratio are other methods that can be used as indicators of body composition (i.e. abdominal obesity).

Despite these limitations, given the importance of studies on biochemical indicators in patients with chronic disease in addition to weight gain or obesity, the results of the current study represent an important contribution to the prevention of some obesity-related diseases. There has been a worldwide increase in obesity rates in recent decades, with subsequent increases in rates of other obesity-related diseases, such as diabetes. These associations are partly mediated by the positive linkages of obesity with the level of triglyceride, a biochemical indicator that independently predicts risks of cardiovascular disease and

diabetes[27]. Further research in this area can be investigated with a different population, nutritional assessment methods (i.e. waist circumference, waist–hip ratio), or study design for use in policymaking.

CONCLUSION

In patients diagnosed with chronic disease, elevated triglyceride levels are independently associated with BMI classifications. Weight increase does not seem to be related to the levels of HbA1c, cholesterol, or albumin. The results emphasize the clinical importance of assessing hypertriglyceridemia among patients with obesity and diagnosed with chronic disease to improve their health status and avoid further comorbidities.

ETHICAL STATEMENT

The study was conducted from November to September 2019 after obtaining approval from the Institutional Review Board of King Abdullah International Medical Research Center, Ministry of National Guard (SP19/210/R).

AVAILABILITY OF DATA AND MATERIAL

Data available on request due to privacy/ethical restrictions

COMPETING INTERESTS

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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AUTHORS' CONTRIBUTIONS

M.A.T.: Conceived and designed the study, contributed to data analysis and interpretation, drafted the manuscript

M.A.A.: Conceived and designed the study, performed the analysis, contributed to the interpretation of the results, revising the manuscript.

A.N.D.: Collected the data, analyzed data and co-wrote the paper

H.A.D.: Collected the data, analyzed data and co-wrote the paper

N.M.S.: Collected the data, analyzed data and co-wrote the paper

T.K.: Conceived and designed the study, helped supervising the project, provided final approval of the version to publish

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